REMARKS

Summary

Amended Claim 1 recites at least one feature not disclosed or suggested by the patents to Yang, Chen '706, Chen '314, Spencer, et al., and Clark, et al. Therefore, are the outstanding rejections of this claim over this art still proper?

Status of the claims

Claims 2, 5, 9, and 10 have been canceled without prejudice. Claims 1, 2, 4, 6, 7 and 8 have been amended. Claims 11-16 have been added. Accordingly, Claims 1, 3, 4, 6-8, and 11-16 are pending. Claims 1 and 11 are independent.

Requested action

Applicant respectfully requests the Examiner to reconsider and withdraw the outstanding objections and rejections in view of the foregoing amendments and the following remarks.

Allowable subject matter

Claim 9 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Applicant gratefully acknowledges the indication that Claim 9 contains allowable subject matter. Portions of Claim 9 have been incorporated into Claim 1.

Submission of drawing correction

Submitted herewith is a Request for Approval of Drawing Changes requesting approval for substituting the attached copy of Figure 4b for the copy in the file.

Formal rejection

Claims 1-10 are rejected under 35 U.S.C. § 112, second paragraph, because the Examiner believes that almost any optical system receiving light from a field of view of two optical elements of any combination of powers reduce the incidence angle of light to the second elements for some ray of light.

In response, while not conceding the propriety of the rejection, Claim 1 has been amended to address the points raised by the Examiner. Applicant submits that as amended, this claim now even more clearly satisfies 35 U.S.C. § 112, second paragraph.

Substantive rejections

Claims 1-5, 7, and 8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Yang. Claims 1, 2, 4/1, 4/2, 7/1, and 7/2 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen '706. Claims 1-8 and 10 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen '314. Claims 1-7 and 10 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Spencer, et al. Claims 1-8 and 10 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Clark, et al.

Response to substantive rejections

In response, while not conceding the propriety of the rejections, independent Claim 1 has been amended. Applicant submits that as amended, Claim 1 is allowable for the following reasons.

Amended independent Claim 1 relates to an optical system comprising an iris, and a layered diffraction optical device laminated with a plurality of diffraction elements. The layered diffraction optical device is provided in front of the iris. The layered diffraction optical device includes a first diffraction element of negative power and a second diffraction element of positive power provided behind the first diffraction element.

New independent Claim 11 relates to an optical system comprising an iris, and a layered diffraction optical device laminated with a plurality of diffraction elements. The layered diffraction optical device is provided behind the iris. In addition, the layered diffraction optical device includes a first diffraction element of positive power and a second diffraction element of negative power provided behind the first diffraction element.

By these arrangements, the incidence angle of light incident on a rear diffraction element is reduced.

In contrast, the patents to Yang, Chen '706, Chen '314, Spencer, et al., and Clark, et al. are not understood to disclose or suggest a layered diffraction optical device laminated with a plurality of diffraction elements, as recited by Claims 1 and 11. Therefore, these patents also are not understood to disclose or suggest that such a layered diffraction optical device is provided in front of or behind the iris or that the layered diffraction optical device includes a first diffraction element of negative power and a second diffraction element of

positive power provided behind the first diffraction element, as also recited by Claims 1 and 11.

The failure of these references to disclose or suggest at least these features proves fatal to establishing a prima facie case of obviousness against Claims 1 and 11, since MPEP §2142, requires that:

> To establish a prima facie case of obviousness... the prior art reference (or references when combined) must teach or suggest all the claim limitations.

For these reasons, Claims 1 and 11 are allowable over the art.

The dependent claims are allowable for the reasons given with respect to the independent claims and because they recite features which are patentable in their own right. Individual consideration of the dependent claims is respectfully solicited.

In view of the above amendments and remarks, the claims are now in allowable form. Therefore, early passage to issue is respectfully solicited.

Applicants' undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,

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MARKED-UP AMENDED SPECIFICATION

Please substitute the following paragraph for the paragraph starting at page 1, line 16 and ending at page 2, line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Hitherto, there is known a method for reducing chromatic aberration by combining plural kinds of glass materials with each other. Another advanced method for reducing chromatic aberration by providing a diffraction optical device3, which develops a diffraction action, on a lens surface or in part of an optical system is disclosed in the literature of SPIE Vol. 1354 International Lens Design Conference (1990), Japanese Patent Laid-Open No. 4-213421 and No. 6-324262, U.S. Patent No. 5,044,706, etc. This method for reducing chromatic aberration is based on [a] the physical phenomenon that a refracting surface and a diffracting surface in an optical system develop chromatic aberration in opposing directions for [the] light of a certain reference wavelength.--

Please substitute the following paragraph for the paragraph starting at page 2, line 5 and ending at line 9. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Further, providing a diffraction optical device is greatly effective in reducing the aberration of an optical system because the diffraction optical device is able to function similarly to an aspherical lens by changing the grating pitch so that its diffractive power is partly changed.--

Please substitute the following paragraph for the paragraph starting at page 2, line 10 and ending at line 21. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--While in a refraction optical system one ray of light remains as it is after being refracted, one ray of light is divided into plural rays of diffracted light of different orders in a diffraction optical system. In the case of employing a diffraction optical device in a lens system, therefore, the structure of a grating must be determined such that light in the wavelength range to be used is concentrated in one particular order (referred to also as the "design order" hereinafter). By concentrating diffracted light in the design order, diffracted light of other orders has a low intensity and can be regarded as being absent if the intensity is zero.--

Please substitute the following paragraph for the paragraph starting at page 2, line 22 and ending at page 3, line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--If rays of diffracted light of orders other than the design order are present, those light rays are focused in positions different from that in which the ray of diffracted light of the design order is focused, and hence generate flare light that is out of focus with respect to the design image plane. For this reason, in an optical system utilizing the diffraction effect, it is important to pay due consideration to [a] the spectral distribution obtained with the diffraction efficiency for diffracted light of the design order and [behaviors] the behavior of diffracted light of orders other than the design order. Thus, to effectively

utilize the color-aberration compensating effect of a diffraction optical device having the above-mentioned properties, it is required that the diffraction efficiency for diffracted light of the design order is sufficiently high over the entire wavelength range to be used, an diffracted light is substantially concentrated in the design order.--

Please substitute the following paragraph for the paragraph starting at page 3, line 18 and ending at page 4, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In the following description, [a] the value of the diffraction efficiency is defined by [a] the ratio of [an] the amount of diffracted light of each order to [a] the total amount of light passing the diffraction optical device. For [the] brevity of explanation, however, light reflected by the boundary surface of a grating, etc., are not taken into consideration in calculating the value of the diffraction efficiency. In Fig. 7B, the horizontal axis represents wavelength and the vertical represents diffraction efficiency.--

Please substitute the following paragraph for the paragraph starting at page 4, line 2 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--The diffraction optical device comprises a grating with a pitch (period) of 200 μm and a height of 1 μm. The grating is made of a material having a refractive index nd = 1.513 and the Abbe's number vd = 50.08. The grating has a glazed structure as shown in Fig. 7A. The graph of Fig. 7B [indicate] indicates the diffraction efficiency when the

incident angle is zero (0 degree). This diffraction optical device is designed such that the diffraction efficiency in the wavelength range to be used is maximized for diffracted light of 1-order (indicated by a solid line in Fig. 7B). In other words, the design order 1-order. Fig. 7B also represents the diffraction efficiency for light of orders around the design order (1-order ± one order, i.e., 0- and 2-order indicated respectively by a broken line and a one-dot-chain line in Fig. 7B).--

Please substitute the following paragraph for the paragraph starting at page 4, line 25 and ending at page 5, line 8. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Japanese Patent Laid-Open No. 9-127322 discloses an arrangement capable of suppressing a lowering of the diffraction efficiency at wavelengths other than the design wavelength. With this related art, high diffraction efficiency is realized over [an] the entire visible range by selecting three kinds of materials and two different grating thickness in optimum combinations, and arranging a plurality of gratings in an adjacently superimposed relation with an equal pitch distribution.--

Please substitute the following paragraph for the paragraph starting at page 5, line 9 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Another arrangement capable of suppressing a lowering of the diffraction efficiency is disclosed in Japanese Patent Laid-Open No. 10-133149. Gratings are

superimposed one above the other to have a two-layered sectional shape. High diffraction efficiency is realized over [an] the entire visible range by optimizing the refractive indexes of materials of the two-layered gratings, the dispersion characteristics thereof, and the thickness of reach grating.--

Please substitute the following paragraph for the paragraph starting at page 5, line 17 and ending at line 24. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–According to the techniques disclosed in the above-cited publications, a diffraction optical device is made of two or more kinds of materials having different dispersion characteristics to reduce phase shifts [occurred] occurring at wavelengths other than the design wavelength when light passes the diffraction optical device. As a result, the dependency of diffraction efficiency of the diffraction optical device upon wavelengths is greatly suppressed.--

Please substitute the following paragraph for the paragraph starting at page 5, line 25 and ending at page 6, line 7. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–By arranging the diffraction optical device in a refraction optical system, color aberration can be reduced to a large extent based on [a] the physical phenomenon that the direction of dispersion of the diffraction optical device is opposed to that of a refraction optical device. It is also possible to compensate for other aberrations by utilizing the

above-mentioned effect that the diffraction optical device is able to function similarly to an aspherical lens.--

Please substitute the following paragraph for the paragraph starting at page 6, line 8 and ending at line 14. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–In the diffraction optical device of the related art, however, the grating has a large depth and the dependency of diffraction efficiency upon the incident angle of light upon the diffraction optical device is increased. This raises [a] the problem that the diffraction efficiency is greatly reduced depending upon the layout of the diffraction optical device in the optical system.--

Please substitute the following paragraph for the paragraph starting at page 6, line 15 and ending at line 22. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Particularly, when an air layer is formed between two gratings made of materials different from each other as disclosed in Japanese Patent Laid-Open No. 11-223717, the flexibility in the selection of the grating materials is greater than that in the diffraction optical device disclosed in the above-cited Japanese Patent Laid-Open No. 10-133149, but the dependency of diffraction efficiency upon the incident angle of light is further increased.--

Please substitute the following paragraph for the paragraph starting at page 7, line 6 and ending at line 13. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--To achieve the above object, the present invention provides a diffraction optical device comprising a first diffraction element and a second diffraction element arranged adjacent to each other, wherein one of the first diffraction element and the second diffraction element has a positive power, the other has a negative power, and the first diffraction element reduces [an] the incident angle of light upon the second diffraction element.--

Please substitute the following paragraph for the paragraph starting at page 7, line 14 and ending at line 21. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Further, the present invention provides a diffraction optical device comprising a first diffraction element and a second diffraction element arranged adjacent to each other, wherein the first diffraction element and the second diffraction element have blazed gratings having blazed shapes oriented in opposing directions, and the first diffraction element reduces [an] the incident angle of light upon the second diffraction element.--

Please substitute the following paragraph for the paragraph starting at page 7, line 25 and ending at page 8, line 3. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Preferably, an air layer is interposed between the first diffraction element and the second diffraction element, or the first diffraction element and the second diffraction element are arranged in an [intimately] intimate contact relation.--

Please substitute the following paragraph for the paragraph starting at page 8, line 7 and ending at line 10. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Preferably, the diffraction elements are formed to have high diffraction efficiency for diffracted light of a particular order over [an] the entire wavelength range to be used in the optical system.--

Please substitute the following paragraph for the paragraph starting at page 8, line 15 and ending at line 16. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–Preferably, [a] the wavelength range to be used in the optical system is a visible range.--

Please substitute the following paragraph for the paragraph starting at page 11, line 11 and ending at line 15. A marked-up copy of this paragraph, showing the changes made thereto is attached.

–In Fig. 1B, grating portions of the two diffraction elements 106a, 106b are illustrated in an enlarged scale for clearly showing an arrangement that two gratings

(kinoforms) of the diffraction elements 106a, 106b have blazed shapes oriented in opposing directions.--

MARKED-UP AMENDED ABSTRACT

Please substitute the following Abstract for the Abstract starting at page 22, line 2 and ending at line 12. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--A diffraction optical device [comprising] includes a first diffraction element and a second diffraction element arranged adjacent to each other. One of the first diffraction element and the second diffraction element has a positive power, and the other has a negative power. The first diffraction element reduces [an] the incident angle of light upon the second diffraction element. As a result, a lowering of diffraction efficiency due to the dependency thereof upon the incident angle of light is suppressed, and flare light is prevented from occurring due to diffracted light of unnecessary orders.--

MARKED-UP AMENDED CLAIMS

1. (Amended) [A diffraction optical device comprising a first diffraction element and a second diffraction element arranged adjacent to each other, wherein one of said first diffraction element and said second diffraction element has a positive power, the other has a negative power, and said first diffraction element reduces an incident angle of light upon said second diffraction element.] An optical system comprising,

an iris, and

a layered diffraction optical device laminated with a plurality of diffraction elements, wherein said layered diffraction optical device is provided in front of said iris,

wherein said layered diffraction optical device includes a first diffraction element of negative power and a second diffraction element of positive power provided behind said first diffraction element.

3. (Amended) [A diffraction optical device] An optical system according to Claim [2]1,

wherein said first diffraction element and said second diffraction element are made of materials having dispersion characteristics different from each other.

4. (Amended) [A diffraction optical device] An optical system according to [any one of Claims 1 to 3] Claim 1,

wherein an air layer is interposed between said first diffraction element and said second diffraction element.

6. (Amended) [A diffraction optical device] An optical system according to Claim [5]1,

wherein said diffraction [elements are] optical device is formed to have high diffraction efficiency for diffracted light of a particular order over an entire wavelength range to be used in said optical system.

7. (Amended) An optical system according to Claim 1 further comprising, [a diffraction optical device according to any one of Claims 1 to 6, and] a refraction optical device.

8. (Amended) An optical system according to Claim [7] 1, wherein a wavelength range to be used in said optical system is a visible range.